evident opportunities for fraud." Quite true — not in many only, but in all; and not only in psychical but in physical experiments of all sorts, which people accept without verifying the results for themselves. But *whose* fraud? We have always been content to rely on the very large class of cases in which the fraud would have had to be *our own*, — fraud in which the investigators actively shared, not merely which they failed to detect. I am far from saying that Dr. Minot or any one else is bound to accept this condition as crucial. But it is surely obvious that he who carries his experiments to the point where they can only be impugned by impugning his good faith, has done — as far as the *quality* of his results is concerned — all that any experimenter in any branch of science ever can do. Nothing remains, after this, but to try to increase the *quantity* of the results, whereby the responsibility for them may be spread over other shoulders.

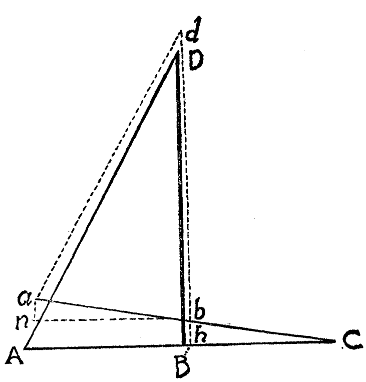
EDMUND GURNEY.

London, Feb. 17.

On tiptoe.

About two years ago Mr. F. A. Pond requested me to work out for him the problem of the human foot regarded as a lever. He thought the essential feature of the case — namely, the attachment of the calf-muscle to the leg below the knee, as well as to the heel, by a tendon — had been ignored.

The question has been of interest to a number of people; and it may be well to bring the true state of the case before writers on anatomy and physiology, inasmuch as it appears to be generally stated that the foot is a lever of the second order when used in rising 'on tiptoe.'



It will do to assume the change of position so small that the foot may be treated as a straight lever. Let $A\ B\ C$ be the foot-lever: A, the point of attachment of tendon to heel; B, the ankle pivot; and C, the point where the foot rests upon the ground. At B erect a perpendicular, BD, to represent the leg-bones, the calf-muscle being attached at D. Now let the muscle contract, and raise B to b. The work done is equal to the weight of the body (supposing one foot used) multiplied by the perpendicular distance through which B is raised, that is, bh of the figure. The power exerted by the muscle is equal to its pull multiplied by the diminution of the distance AD. As B rises to b, let A rise to a, and D to d. Through b draw bn parallel to AC, and drop an. Now, bC is to bh as ba is to an. The line an is very approximately the amount of shortening of the muscle. The sign of the 'mechanical advantage' will be positive, zero, or negative, according as AB is greater than, equal to, or less than, BC. A lever of the 'second order' implies advantage of positive sign; that is, so-called 'mechanical advantage.' A lever of the 'third order' implies mechanical disadvantage. A lever of the 'first order' is capable of affording mechanical advantage or mechanical disadvantage, as the ratio of the arms determines: hence, when one rises on tiptoe, the foot is a lever of the first order.

An attempt has been made to regard the case as of the second order, by calling the upward pull at A, y, and the pressure of the body at B, x. The pull y will be transferred as a downward thrust of y to B; so that we have (if, for instance, $AB = BC$) an upward force of y at A, and a downward force of $x + y$, equal to $2y$, at B. But the traverse of y is not twice the traverse of $2y$. Thus the 'principle of work' limits the case to the 'first order.'

F. C. VAN DYCK.

New Brunswick, N.J., Feb. 28.

Increase of the electrical potential of the atmosphere with elevation.

Very many observations of the electrical potential of the atmosphere have been made at different places in this country during the past year, under the auspices of the U.S. signal office. Among others, at Washington, D.C., a series of simultaneous observations has been carried on at the instrument room of the signal office and at the top of the Washington monument, the highest known edifice. The object of the present paper, published by permission of the chief signal officer, Gen. A. W. Greely, is to present in brief some of the results of those observations, particularly those bearing on the value of the intensity of the electrical force of the atmosphere at an elevation of five hundred feet, and the variations of the potential under different conditions of weather.

Beccaria, De Romas, Henley, and Cavallo, all noticed that the more elevated the position of the collecting apparatus, the greater the degree of electrification. Schübler (*Schweigg. journ.* ix. 348) was the first to make measurements of the difference, and found that a positive electrification increased, at least up to a height of 50.5 metres. His results with an electroscope were as follows: —

Height (metres)..........	9.7	16.2	24.4	47.1	49.4	55.6	58.5
Deflection (degrees)......	15	20	26	50	53	58	64

Sir William Thomson, it is sometimes stated, found an increase of from 200 to 300 volts for three metres. This value, however, was one obtained with a portable electrometer on a flat open sea-beach on the island of Arran, the height of the match being nine feet above the earth. The readings varied from 200 to 400 volts, so that "the intensity of electric force, perpendicular to the earth's surface, must have amounted to from 22 to 44 Daniell elements per foot of air" (Thomson, reprint of papers, xvi. 281). It is also intimated that on other dates this value might have been twice as large, or yet much smaller. Mascart and Joubert found that if two water-collectors were placed in the same vertical line, the one five, the other ten metres high, the indications were in the main alike, and in the ratio of 1 to 2. Some experi-